Quantum Critical Point in Doped Manganites?

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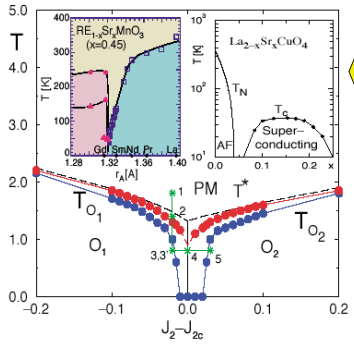
Motivation: Test the assertion that the $Pr_{0.65}(Ca_ySr_{1-y})_{0.35}MnO_3$ system has a quantum critical point (QCP) for y~0.7.
Approach: Synthesize a series of samples covering the transition from ferromagnetism (FM) to charge-order (CO) and study their temperature dependent structure and magnetism using neutron powder diffraction.
Accomplishment: The behavior of the system is better interpreted as arising from an inhomogeneous ("phase segregated") mixture of ferromagnetic and charge-ordered regions. The lack of a charge-disordered paramagnetic phase persisting to T=0 argues against the QCP scenario.

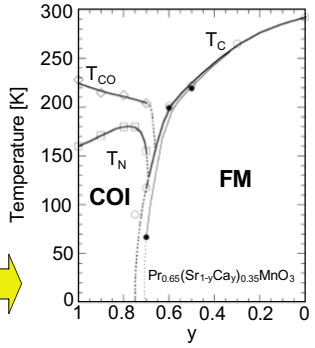
Background



J. Burgy et al. PRL 87, 277202 (2001)

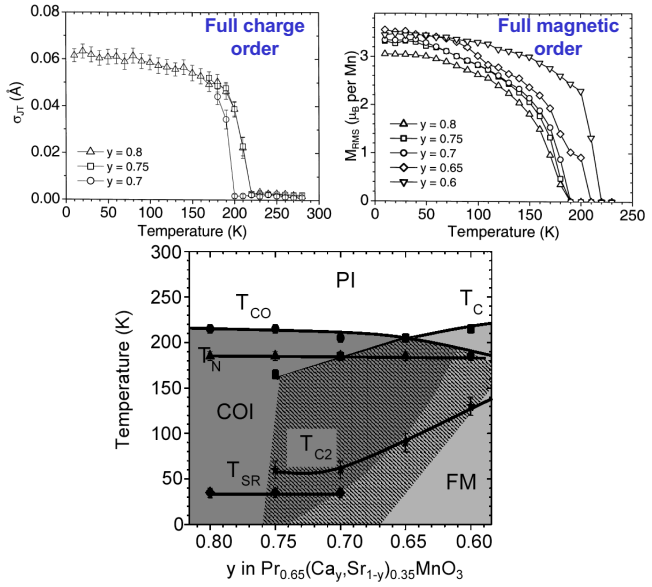
Simulations predict a "smeared out" first order phase transition due to chemical and/or structural disorder. A region near the transition remains disordered at T=0, behavior that has been labeled "QCP-like."

$Pr_{0.35}(Ca_ySr_{1-y})_{0.35}MnO_3$ has been suggested to support these simulations, with a disordered phase persisting to T=0 near y=0.7



Y. Tomioka and Y. Tokura J. Alloys and Cpds 326, 27 (2001)

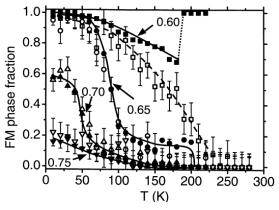
Phase Diagram via NPD



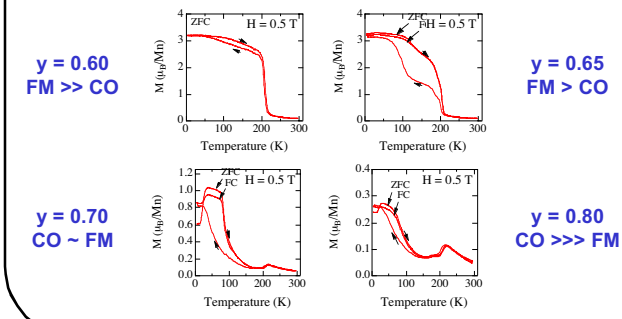
Neutron Powder Diffraction (NPD) reveals that . . .

- ***All*** compositions have ordered phases for ***all*** T < 220 K
- Nucleation of FM phase occurs at T>150 K, but phase fraction grows at T~100 K; Tomioka and Tokura T_C line tracks this phase growth
- *Behavior better described by phase inhomogeneity model than QCP scenario*

Evolution of Magnetism

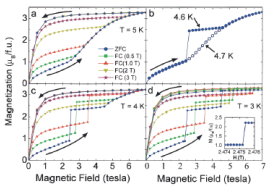


Neutron diffraction identifies "T_{C2}," the temperature where the FM phase fraction rapidly increases. It agrees well with the magnetization data



Future Directions

Phase segregated manganites have interesting low temperature meta-magnetism. We are growing crystals and films to study these properties.



R. Mahendiran et al. PRL 89, 286602 (2002)

G. Blake, L. Chapon, P.G. Radaelli, D.N. Argyriou, M.J. Gutmann and J.F. Mitchell, Phys. Rev. B 66, 144412 (2002).

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